# RECOMMENDATIONS FOR IMPROVING PESTICIDE APPLICATOR TRAINING PROGRAMS IN TAIWAN

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## ABSTRACT

This paper contains recommendations for improving pesticide applicator training programs in Taiwan based on licensing and training procedures in the U.S.A. and some Western European countries. Also included in this paper is information about a new European Community initiative on mandatory inspection and certification of pesticide application equipment.

In the U.S. restricted use pesticides can only be used by a certified applicator or a person under direct supervision of a certified applicator. Certified applicators must pass written exams demonstrating their knowledge about pesticide use and have met other licensing requirements. The process of license renewal is different in the U.S. and in Western European countries. In most U.S. states, renewal of a license is required every three years. Some European countries do not require recertification, others have recently adopted the concept of recertification and continuing education that comes with the recertification process.

One important difference between the procedures for licensing applicators in the U.S. and in some European nations is in testing the knowledge level of an applicator prior to issuing a license. Most European candidates for a license must pass a one-on-one oral examination and hands-on problem solving session in addition to written tests. To improve the quality of pesticide applicator training programs in Taiwan, the European and U.S. procedures for applicator education and inspection of application equipment should be carefully reviewed. The procedures found suitable for conditions in Taiwan should be revised if necessary, and adopted.

## INTRODUCTION

About a third of all pesticides produced worldwide are sold in the U.S. Pesticide industry sales reached $8 billion in 1992 (NACA, 1993). Growing concerns about pesticide contamination of ground and surface water and increasing chemical costs make accurate application of pesticides even more important than in the past. The effects of pesticides are greatly influenced by the method and timing of application, and the operation and accuracy of the equipment used. Applying too little pesticide causes ineffective pest control which may require the added expense of respraying. Applying too much pesticide adds to the cost, may damage the crop, and may lead to environmental pollution. Labels on pesticide containers indicate the proper application rates. However, these rates can be achieved only if the application

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equipment is suitable for the job, calibrated frequently, and operated properly.

Regulatory guidelines in the U.S. indicate that the application should be within 5% of the recommended label rate. Although it is questionable whether an application accuracy with an error margin of 5% can be achieved in "real world" situations, improvements in application accuracy are needed and can be achieved with proper selection, calibration, and operation of application equipment. To obtain such high accuracy levels in application of pesticides requires well-educated and qualified persons applying and handling chemicals.

Although there may be differences in the format for educational programs conducted in the U.S. and in most Western European Countries, all applicators are educated on how to operate and calibrate application equipment properly, and apply pesticides in most effective manner. While some countries do not require a license to apply pesticides, other countries, including the U.S., require a license for applying certain classes of pesticide. The requirements to obtain a license varies from state to state in the U.S., and from country to country around the world.

Very recently, some countries in Western Europe have gone one step further and adopted procedures to certify application equipment. A thorough inspection is conducted as part of the certification process. Sprayers which fail this inspection cannot be used for applying pesticides. Rules of equipment inspection vary from country to country. Some European countries have objected to such regulations.

## OBJECTIVES

To conduct new educational programs and improve existing programs for pesticide applicators in Taiwan, procedures followed by other nations around the world should be carefully evaluated. The objectives of this paper are:

1) To highlight the similarities and contrasts among pesticide education and licensing programs in the U.S. and in some Western European nations.
2) To provide information about the new European Community initiative on inspection and certification of pesticide application equipment.
3) To offer some recommendations on improving quality of educational programs currently offered to pesticide applicators in Taiwan.

## PROCEDURE

To obtain information on pesticide applicator education and application equipment inspection programs in Europe, a questionnaire was sent to knowledgeable persons in the following countries: Belgium, the Czech Republic, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, and the United Kingdom. The participants of this survey were selected because they are directly involved in pesticide applicator education programs, or are at least qualified to answer the survey questions. To clarify answers given to some of the questions, participants were contacted again, either face-to-face or by telephone, Fax or Internet.

A summary of U.S. and European programs for training pesticide applicators and inspecting application equipment is presented below. Detailed information about these programs in the U.S., and responses to individual questions by survey participants from Europe are given in the paper by Ozkan (1996). Specific responses to a small number of key questions are presented in this paper.

## SUMMARY OF KEY FINDINGS

a) *Pesticide Applicator Education in the US and in Western Europe*

The procedure for teaching topics related to application equipment varies from state to state in the U.S., and from country to country around the world. In the U.S., every state training program must meet the minimum established in Federal Insecticide Fungicide Recovery Act (FIFRA) requirements, but many states have their own pesticide laws that are more stringent than the federal law.

In the U.S., some pesticides pose special risks to the public health and environment and therefore are classified "restricted use". All other pesticides are classified as "general use". Restricted use pesticides can only be used by a certified applicator or a person under direct supervision of a certified applicator. Certified applicators must pass written exams demonstrating their knowledge about pesticide use and have met other licensing requirements. These training sessions include core subject matter (safety, environment, regulations, pesticide waste management, equipment calibration etc.) and topics related to specific crops and categories of certification (agronomic crops, horticultural and ornamental crops, aquatic pest control, home pest control). The applicators must attend a minimum 5 hours of educational presentations which should include a minimum of 1 hour of core material, half hour of training on a specific category for which the applicator will be certified.

Proper operation and calibration of pesticide application equipment should be an important part of the total knowledge which all applicators are expected to possess in order to apply pesticides accurately. Although generally the pesticide applicator education programs in the U.S. are the envy of many nations around the world, the part of the program associated with selection, operation and calibration of application equipment receives inadequate attention.

While some states address the topic adequately, most others allocate only 30 minutes to cover application equipment. This training process has generally been ineffective. In many cases, the large size of the audience attending these lecture-oriented teaching activities has not allowed audience participation and interaction with the instructor. In some cases, the subject matter is covered by using slide sets and videotapes with no instructor available to answer questions. The training process has not motivated applicators to calibrate their sprayers.

The written test which the applicators take before obtaining their certificates do not serve as an indicator of the applicator's knowledge in proper operation, maintenance and calibration of application equipment. For example, the Ohio exam for commercial applicators contains 80 questions from the core material, and 25 to 35 questions from a specific category chosen by the applicant. Out of the approximately 110 questions, no more than 10 are directly or indirectly associated with application equipment. Most of these questions, such as mixing chemicals, drift, nozzle selection, properly cleaning a nozzle, reasons for calibration, proper cleaning of a sprayer etc., can be answered by simply using common sense. Since a score of 65% is a passing grade, someone can miss all of the equipment related questions and still become a certified pesticide applicator. This situation is not specific to Ohio only. Delivery of educational programs for training pesticide applicators and the content of exams given to applicators do not change much from state to state.

On the other hand, some European countries require an examination that includes a direct, one-on-one testing with spray equipment before a certified pesticide applicator rating is issued. Prior to this hands-on type exam, the applicator is required to go through a training school which teaches the basic principles of sprayer operation and calibration, and proper handling of pesticides. These schools typically last one to four days depending on the experience of the applicator.

Another concern with U.S. applicator licensing is that only the supervisor is required to hold a valid license. Under his/her supervision, personnel who are not licensed may handle the pesticides and operate the spray equipment. The assumption is that the supervisor will provide adequate training to his/her employees before spraying begins. If supervision is close enough, this policy is adequate and can be practiced successfully. Unfortunately, there is no way of knowing whether the supervisor adequately trains the workers. In many European countries, everyone who is actively engaged in applying pesticides has to obtain a valid applicator license.

The process of license renewal is different in the U.S. and in Western European countries. In most U.S. states, renewal of a license is required every three years. The applicant must either take the written test and pass, or attend educational programs for a minimum of 5 hours. During these structured educational programs the applicator is provided with the latest information on various aspects of pest control. Until recently, recertification of an operator was not necessary in Europe. Once a license was obtained, it was valid indefinitely. Although some European countries still do not require recertification, others have adopted the concept of recertification and continuing education that comes with the recertification process.

*b) Inspection and Certification of Application Equipment*

All countries included in this survey have been conducting voluntary equipment inspection programs for several decades. The low level of participation by pesticide applicators and increasing public concerns about the misuse of pesticides have forced regulators in some countries to implement much stricter rules governing the condition of application equipment. Germany and Belgium have made equipment inspection mandatory since 1993 and 1995, respectively. If a sprayer passes the mandatory inspection, a decal, representing the seal of approval by the regulating agency is placed on the sprayer. These inspections typically include the following: general condition of the sprayer (fittings, hoses, leakage, boom stability, pumps, nozzles etc.), stability of pressure at the nozzle, condition of the pressure gage, pressure variations among boom sections, change in pressure at the nozzle when any one section of the boom is shut off, flow rates of all nozzles, and accuracy of sprayer monitors and control units.

In the first month of the mandatory inspection program in Belgium, 1556 sprayers were inspected. About 87% of these sprayers passed the inspection. The major reasons for rejection of sprayers included faulty pressure gages (43%) and nozzles (41%) with a incorrect flow rate, angle or type. The goal of the Belgium government is to have all crop sprayers (about 28,000) inspected before December 1998. In Belgium, the inspection fee depends on the length of the sprayer boom; ranging from 2500 Belgium Francs ($83) for sprayers with booms less than 12 m (40 ft) long to 4000 Belgium Francs ($132) for sprayers with booms greater than 22 m (72 ft).

Currently, only boom-type field sprayers have been subjected to mandatory inspection. However, plans are underway in both Germany and Belgium to expand this program to include high-pressure orchard sprayers.

## SPECIFIC RESPONSES TO SOME KEY QUESTIONS IN THE QUESTIONNAIRE

Answers given by the survey participants to a small number of key questions are presented below. A complete set of survey questions and responses are given in the paper by Ozkan (1996). In addition to responses from European countries, information on Ohio's pesticide applicator training (PAT) program has also been presented below to provide a reference point for how pesticide applicators are trained in the U.S. It is important to note that although some common objectives and regulatory guidelines set by the USEPA and USDA have to be met by all states, some aspects of the PAT process in the U.S. vary from state to state. For example, the fee structure may be different in different states. Therefore, anyone interested in finding data for a specific state should contact the coordinator of the PAT program in that particular state.

### A. Questions related to licensing and certification process

1) *What is the fee paid to get a license?*

| | |
|---|---|
| Belgium | Free |
| Denmark | Free (must pay for courses taken prior to receiving the license) |
| Czech Republ. | $10 |
| Germany | $200 to sell pesticides, $300 to apply |
| Italy | $10 |
| Norway | $170 |
| Spain | Free |
| Sweden | $115-$220 |
| U.K. | $150 |
| Ohio, U.S.A. | Commercial applicators must pay a license fee annually. This ranges from $20 for Public Operators (working for city/state/federal government) license to$100 for a Custom Applicator (owner, manager of a business) license. Private applicators do not purchase a yearly license. A $30 certification fee is paid upon passing examinations and at beginning of each 3 year certification period. |

2) *How long is the license valid?*

| | |
|---|---|
| Belgium | No expiration |
| Denmark | No expiration |
| Czech Republ. | No expiration for University educated, 5 years for others |
| France | 5 years |
| Germany | No expiration |
| Italy | 5 years |
| Norway | 10 years |
| Spain | 5 Years |
| Sweden | 5 years |
| U.K. | No expiration |
| Ohio, U.S.A. | The minimum certification period by law nationally is 5 yrs. Some states like Ohio have shortened the time period. License is valid for one year for commercial applicators. Certification is required every 3 years for both private and commercial applicators. |

3) *Is the license valid only for a particular application type or equipment?*

| | |
|---|---|
| Belgium | Special license depending on the type of pesticide applied |
| Denmark | No, one license for field applications |
| Czech Republ. | No, one license for all applications |
| France | No license needed to apply |
| Germany | No, one license for all applications |
| Italy | No, one license for all applications |
| Norway | No, one license for all applications |
| U.K. | Foundation test + test(s) for specific equipment |
| Ohio, U.S.A. | No, one license for all applications |

## B. Questions related to educational programs conducted to train applicators.

1. *Length of educational programs? (Hours, days, etc. )*

| | |
|---|---|
| Belgium | 120 hours |
| Denmark | 72 hours |
| Czech Republ. | Varies |
| France | 150-200 hours |
| Germany | 3 days for sellers of pesticides; 4 days for applicators |
| Italy | 20 hours |
| Norway | 3 days |
| Spain | Basic, 20 hours; advanced, 60 hours; special applications, another 25 hours |
| Sweden | 3-4 days (depending on hazard classifications) |
| U.K. | 2 days and upwards |
| Ohio, U.S.A. | Varies from state to state. In Ohio, One hour core material training, half hour for each category certified; then build up to a minimum 5 hours at the end of third year with more of the same or any approved course. Private applicators need 1 hour of core, then build up to a minimum of 3 total hours of training. Attending to these educational programs for recertification is not required. At the end of 3 year period, the applicators either must take the test and pass, or in lieu of retesting, they may attend educational sessions. |

2. *Are there specific sessions in the programs for different types of application equipment/methods*

| | |
|---|---|
| Belgium | No at this time; discussions are underway to provide separate programs for different equipment |
| Czech Republ. | No |
| Denmark | No, only one category concerning field spraying |
| France | No |
| Germany | No |
| Italy | No |
| Norway | Yes (Categories: conventional field crop sprayers, orchard, greenhouse, forestry, nursery, general) |
| Spain | No (Applicators can choose either the basic or the advanced session.) |
| Sweden | Yes (two general sessions; seed treatment and general application. Those in the general application group are further subdivided into small groups such as agriculture, horticulture, nursery, parks etc., but they all receive the same types of course work, lectures, etc.) |
| U.K. | Yes |
| Ohio, U.S.A. | No |

3. *Who is in charge of providing educational programs to pesticide applicators?*

| | |
|---|---|
| Belgium | Professional associations and government personnel organize; researchers, scientists, professors from universities teach. |
| Denmark | Agricultural colleges, business schools and centers for labor market courses. |
| Czech Republ. | Personnel from government research institutions and universities. |
| France | Agricultural college (high school) teachers, personnel from Ministry of Agriculture, Division of crop protection. |
| Germany | Plant Protection Office of the Chamber of Agriculture |
| Italy | Personnel from Regional government offices, private organizations, university |
| Norway | Local personnel, but these people receive training at the University periodically |
| Spain | Agriculture Dept. of the regional government has overall responsibility. Others such as application specialists from private and other government organizations and universities. |
| Sweden | Provincial government personnel, sometimes with help from University personnel |
| U.K. | University instructors, and private people who receives training periodically at Universities. |
| Ohio, U.S.A. | Cooperative Extension Services housed in Public Universities. |

4. *Are the participants required to take a test to receive the applicator license? If _yes_:*

*a) How is the test given (written, oral, combination of both)*

*b) Duration of the test (hours?)*

*c) Does everyone take the same test? (If _no_, explain what types of tests are there, and who takes what type of test?*

| | |
|---|---|
| Belgium | Yes. A 30 to 40 minute oral exam given by the Dept. of Public Health on topics associated with the type of application the person will be engaged in. |
| Denmark | Yes. Written and practical tests that take 2-3 hours. Everyone takes the same test. |
| Czech Republ. | No test given |
| France | Yes. A combination of written and oral test is given. Every one takes the same test. |
| Germany | A one-hour test is given. This includes an oral portion that is about 30 minutes long for applicators, 15 minutes for sellers of pesticides. Sellers are not asked questions related to application technology. |
| Italy | Yes. A 30-minute written test is taken by all applicators. |
| Norway | Yes. A one-hour written test is taken by applicators. Test questions are different depending on the specialty area of the applicator (Field sprayers, orchard, greenhouse, nursery, forest, etc.) |
| Spain | Yes. The same one-hour written test is taken by all. |
| Sweden | Yes. The same two-hour written test is taken by all. |
| U.K. | Yes. The test is mainly oral and last from a half day to a day. The participants are required to take a test for each equipment they will be using when applying pesticides. |
| Ohio, U.S.A. | A test is not needed to obtain a license, but it is required for certification. Every state is different in how categories are dealt with for commercial applicators. In some states, private applicators are not given written exams particularly for categories. Some states have open book exams. In general, within a given state all commercial applicators would take the same core material test and then they usually have to take a category exam that relates to the type of target crop/pest situation they will be working in. |

Many states have categories for some specialized application methods such as aerial, fumigation and chemigation. In Ohio there are 33 categories commercial applicators can be certified for. For private applicators, if they are tested, most states only test on core topics not categories or only a few categories such as agricultural plant or agricultural animal. In Ohio written tests are given in 13 categories. In addition, everyone takes the same core exam.

## C. Questions related to duration of a license and renewal procedures

*For how long is the license valid? If renewal of licenses is required:*

*1) Are applicators required to attend educational programs*

*2) Are the educational programs for license renewal different than the ones attended by the first-time licensees?*

*3) Are applicators required to take a test again?*

*4) Is there a fee associated with renewing the license (if _yes_, how much)?*

| | |
|---|---|
| Belgium | License renewal is not required currently. Discussions are underway to make license renewal a requirement for those who wish to keep their licenses valid. |
| Denmark | License renewal is not required. |
| Czech Republ. | License is valid forever for people with a university degree. For others it is valid for 5 years. For renewal, participation in educational programs and taking a test are required. Test educational programs and the test given are the same as those for new applicators. A fee is paid for renewal ($10). |
| France | Renewal is required every 5 years. Participation in some educational programs or a test are not required. Fee required. |
| Germany | License is valid indefinitely. Renewal is not required. |
| Italy | License is valid for 5 years. Educational programs for license renewal are five hours shorter in total duration than the programs for new applicators. Applicators take the same test the first time they receive their licenses and for renewal. The fee for renewal is $10. |
| Norway | Renewal of a license was not required until recently. Currently a license is valid for 10 years. Participation in educational programs is required. Level of instruction and the fee have not been determined yet. |
| Spain | The license is valid for 10 years. Teaching material is updated periodically. Applicators take the same test the first time they receive their licenses and for renewal. Also a medical test is given with special attention given to the level of Acothil-Colinostheraso level in the blood. No fee is required for renewal. |
| Sweden | License is valid for 5 years. For renewal applicators must attend a 1-day course and pass a test which is the same they have taken when obtaining the license the firs time. The fee is $29. |
| U.K. | License is valid indefinitely. Renewal is not required |
| Ohio, U.S.A. | Licensing and certification are separate for commercial applicators. They may choose to pay for a license every year but their certification may be valid for 3-5 years. |

## RECOMMENDATIONS TO IMPROVE QUALITY OF PESTICIDE APPLICATOR TRAINING PROGRAMS IN TAIWAN

1. The policies governing PAT programs and the content of educational programs should be reviewed. The review committee should include people who are knowledgeable about the PAT programs around the world, and representatives from organizations and Extension Personnel who teach subjects related to pesticide application technology.
2. Emphasize hands-on training in educational programs. Teaching sprayer calibration in a classroom setting has not been effective.
3. Provide additional resources, especially personnel for delivering hands-on training.
4. Those who will be actually applying pesticides and using the application equipment must pass two exams before they are given an applicator license. The first exam should be a written exam to test applicators, general knowledge level on pests, pesticide formulations, safety and environmental concerns, and other pertinent topics. The second exam should include both a written part covering topics associated with efficient use of application equipment, and an oral part focusing on hands-on trouble shooting and equipment calibration.
5. Hands-on training and exams related to application equipment should be conducted by individual "private trainers" perhaps under limited government/university supervision. The "trainers" could be Extension personnel, technical representatives and dealers from chemical and sprayer companies, and others with sufficient training in sprayers and spray technology.
6. Trainers should be licensed, and keep their license current by periodically attending training programs offered by "Master Trainers" (Extension Specialists and others from state regulatory agencies, equipment and chemical companies). This type of "train-the-trainer" concept used in some European countries should be carefully reviewed and adopted if found applicable to conditions in Taiwan.
7. High-quality in-service training programs should be offered to "trainers" and regional PAT educators frequently but not less than once a year.
8. A standard fee across Taiwan should be set for the "trainers" to charge each applicator receiving training from the "trainer", and for administering the oral (hands-on) segment of the examination process. Although it is preferred that this program be self supporting, some economic incentives or subsidies could be provided by the state and federal agencies to the applicator who is willing to complete a rigorous training and examination process.
9. The fees should be kept at a level that can sustain high-quality educational programs.
10. Educational programs related to spray technology and equipment calibration should be hands-on and conducted outdoors.
11. The applicators should be required to attend a comprehensive educational program every third year to keep their license valid. However, if a separate equipment session and exam are to be held as described above, then the

applicators should be required to take this separate equipment session/exam every six years instead of every three years.

12. If personnel at regional Research and Extension Stations are given responsibility for educating pesticide applicators, at least one person in each Station should be assigned as leader for PAT educational programs. If these specialists are asked to carry out a wide range of educational programs, including PAT programs, in their regions, there will not be enough time left for any one educator to implement quality hands-on sprayer technology training sessions for applicators.

13. Instead of the mandatory equipment inspection programs implemented in some European countries, we should put more emphasis on educating applicators and letting them make sound management decisions when they apply pesticides. Adding a special hands-on application technology session (such as field days, sprayer "calibration clinics") to ongoing educational programs is likely to be a more productive, cost-efficient and a less bureaucratic method to reach the same goal.

## CONCLUSION

Growing concerns about pesticide contamination of ground water and higher chemical costs make accurate application of pesticides increasingly important. Therefore, it is vitally important that pesticides be applied by trained and licensed operators. Applicators must receive strong educational training before they are awarded their license to apply pesticides. To teach efficient application of pesticides and proper operation of application equipment, we have to increase the time allocated to application equipment related topics in regional training programs. Educational programs should include hands-on training, conducted by knowledgeable teachers, in small-group settings. European and U.S. procedures for applicator education and inspection of application equipment should be carefully reviewed, and procedures found suitable for conditions in Taiwan should be revised if necessary, and adopted.

## REFERENCES

NACA. 1993. 20th Annual Industry Profile Study, National Agricultural Chemical Association. Pesticide & Toxic Chemical News, June 2, 1993, p. 30.

Ozkan, H.E. 1996. Procedures for licensing pesticide applicators and certifying application equipment in Western Europe. ASAE Paper No. 961083, ASAE , St. Joseph, MI 49085.